Making 10G EPON A Reality

Opulan Technologies Corp

FTTH China 2009

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   - Japan, China, US and others

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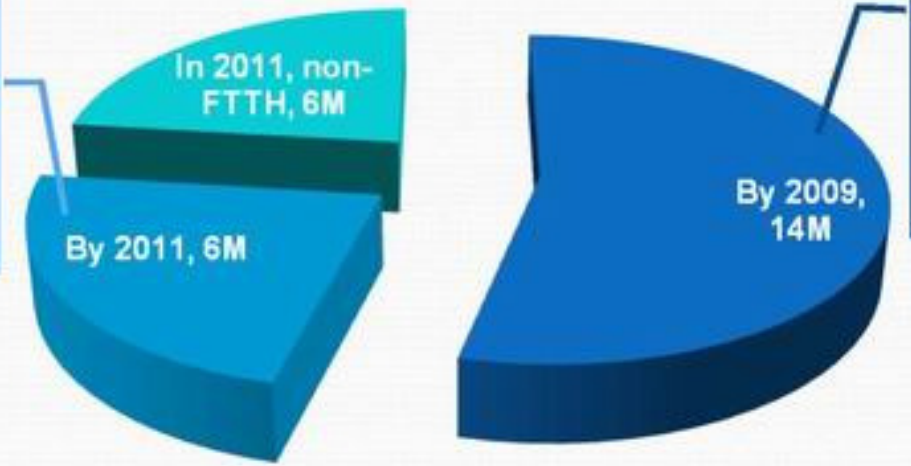
Leading FTTx Markets - Japan

- 80% FTTH, 20% FTTB
- 77% of households installed with ONTs
- Majority of FTTH subscribers have100Mbps (dedicated)
- 10G EPON will start deployment

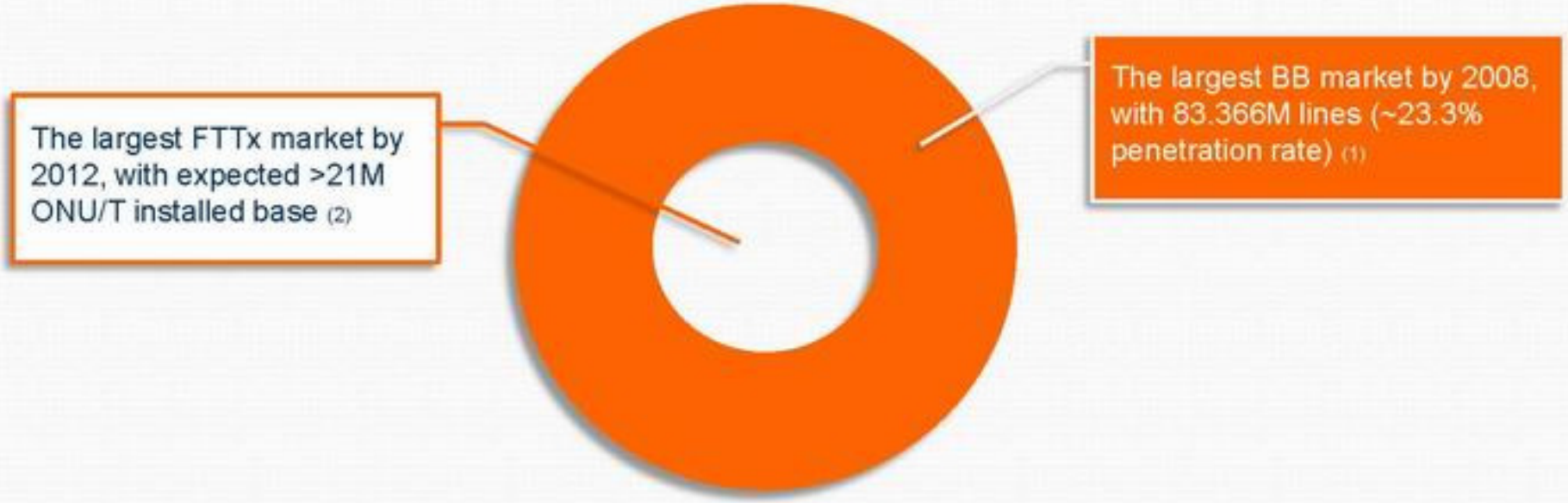


- 60% FTTH, 40% FTTB
- 54% of households installed with EPON ONTs
- Today's bandwidth for each FTTH subscriber is 100Mbps (best effort)

NTT has about 70% market share today. Other operators, including KDDI, K-Optical, together have 30%. KDDI is working with Japan's largest cable MSO, J-Com, in regards to IPTV. Meanwhile, the government is expected to relax its regulations on content sharing and IPTV licensing. There are at least one HDTV set for each home today.

Data: Paul Budde Communications, 6/2009, Ministry of Internet Affairs and Communications, Japan, 2009, and Opulan's own market research

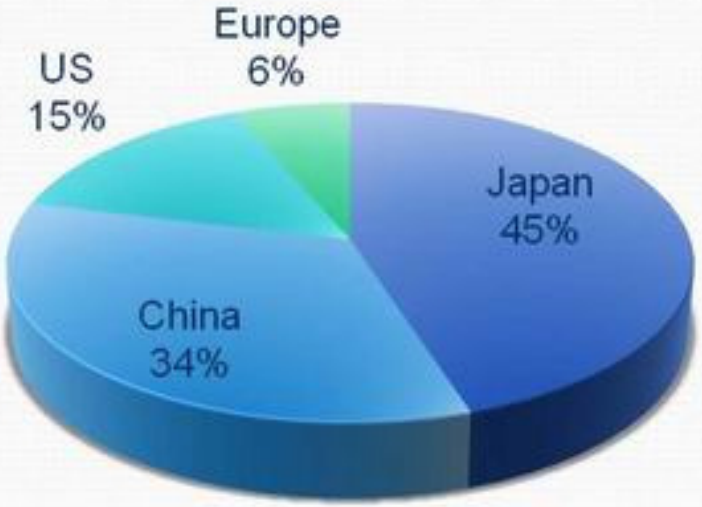
Leading FTTx Markets - China



China's telecom operators are also among the earliest in testing 10G EPON technology, and conducted the industry's first, chip-level IOP testing in early July 2009.

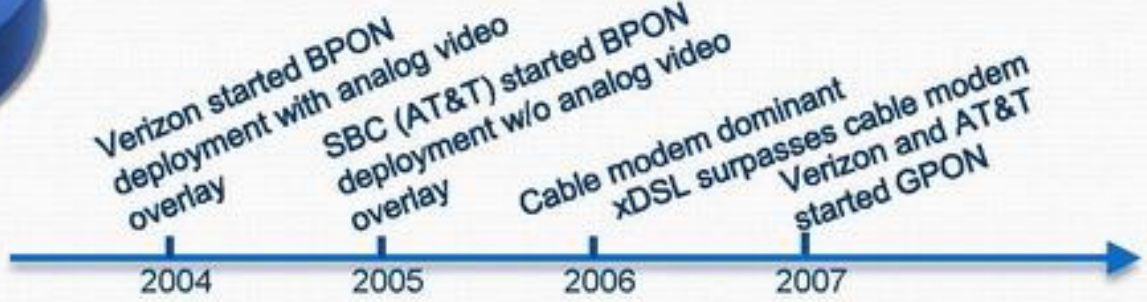
Data: (1) Point-Topic, 2009 (2) collected from equipment markers in China

Global FTTH & PON Progress



Based on FTTH Council data, by 2008 Japan has 10M, China has 7.5M, US has 3.3M and Europe has 1.4M households connected by fiber.

GPON has made some progress in North America.



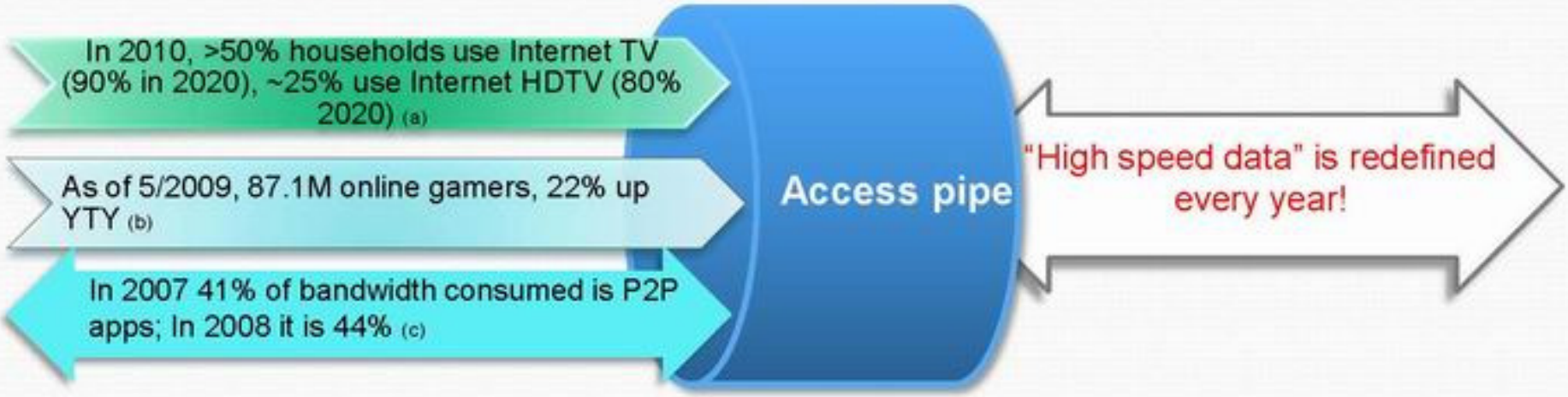
Brookseven
Wednesday July 15, 2009 2:18:03 PM

... ... EPON is going nowhere in the Tier 1 western carriers. Why? It is really simple. Submit EPON to be controlled by FSAN and it might be the next standard. Keep it in IEEE and the Western Carriers will avoid it like the plague. ... ...

seven

Fast Evolving Traffic Pattern

U.S. Market Studying



In US market today, there are three significant factors that make up bandwidth consumption:

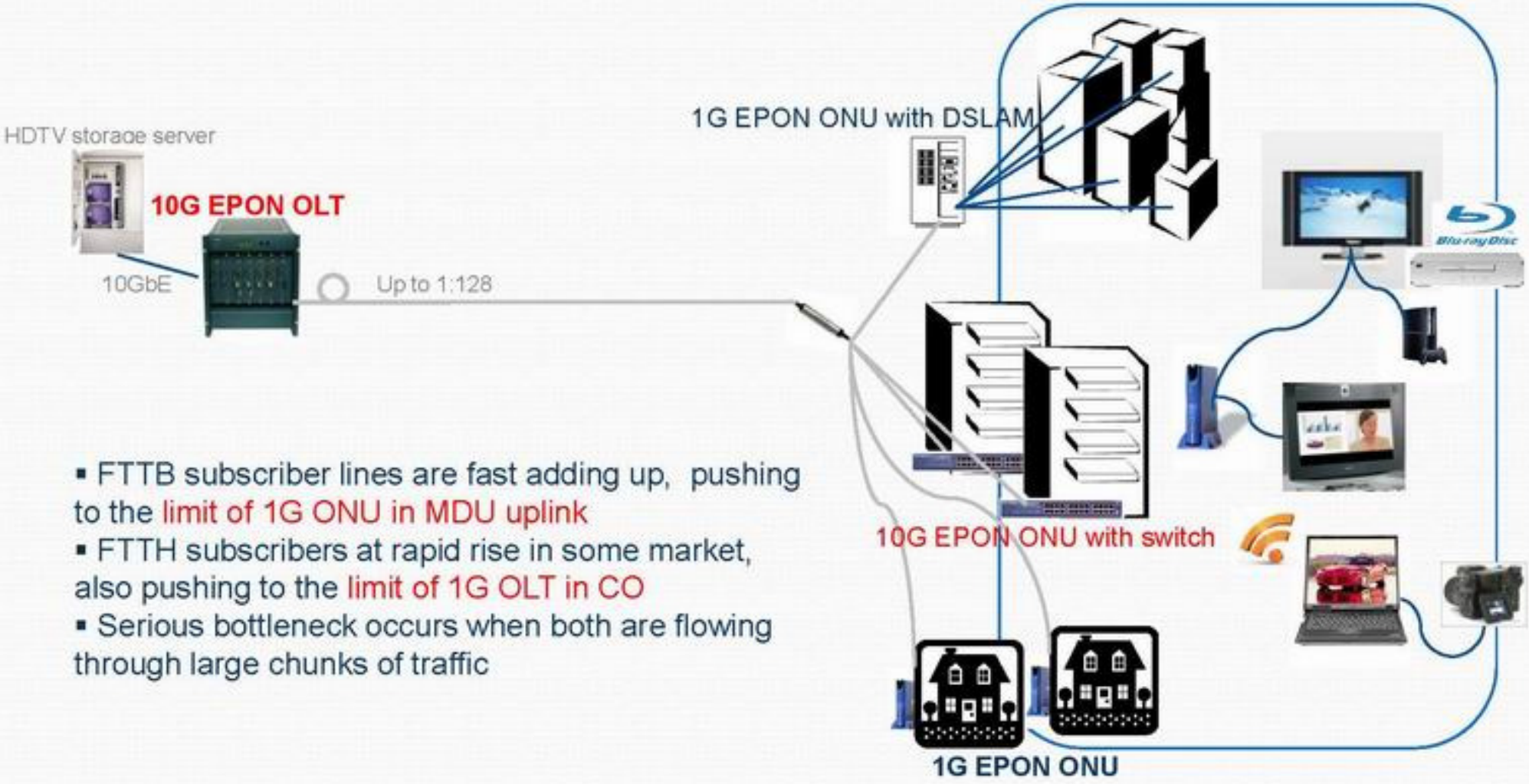
- Online video (including HD DTV) broadcast or download (in forms of IPTV/VOD, YouTube/user-generated video, etc.);
- Interactive, online gaming;
- P2P applications, often P2P download/upload of HD movie or large data/graphics files.

Bandwidth-hungry video streams eat up whatever available in the pipe, and makes services of <10Mbps a serious bottleneck.

Data source: (a) Ethernet Alliance, 5/2009 (b) ComScore, 5/2009 (c) Sandvine, 6/2008

Compelling 10G Driving Force

"…are all innovations that were generally not predicted when today's networks were designed."
– Scott Wilkinson, PhD, Hitachi Telecom USA



- FTTB subscriber lines are fast adding up, pushing to the limit of 1G ONU in MDU uplink
- FTTH subscribers at rapid rise in some market, also pushing to the limit of 1G OLT in CO
- Serious bottleneck occurs when both are flowing through large chunks of traffic

Why 10G EPON?

- The most compelling requirement for the next-generation PON is to provide significantly more bandwidth per user using the same OSP.

- In two largest PON markets, Japan and China, EPON is ubiquitous, with almost 30 million 1G ONUs in FTTx deployment.

- When 1G EPON ONU or 2.5G GPON ONT in MDU aggregation point is being pushed to its limit, 10G ONU will be installed, and thus 10G OLT must be deployed simultaneously in CO.

- Increasing installment of 1G ONTs in FTTH deployment also requires installation of a new OLT in CO, 10G OLT is the perfect choice for upgrading.

- 10G EPON offers the lowest per Megabit cost comparing to other competing technologies.

- The most technologically logical, most economically sound, and seamless migration of 1G EPON OLT is 10G EPON OLT, with respect to carriers' CapEx and OpEx.

- A 10G OLT system can replace 1G OLT without creating service interruption to 1G ONUs that do not need upgrade for continuous operation.

- 10G asymmetric EPON (10G DS/1G US) is commercially ready, and 10G symmetric technology supporting 10G DS/10G US will be commercially ready late this year.

10G EPON Economics

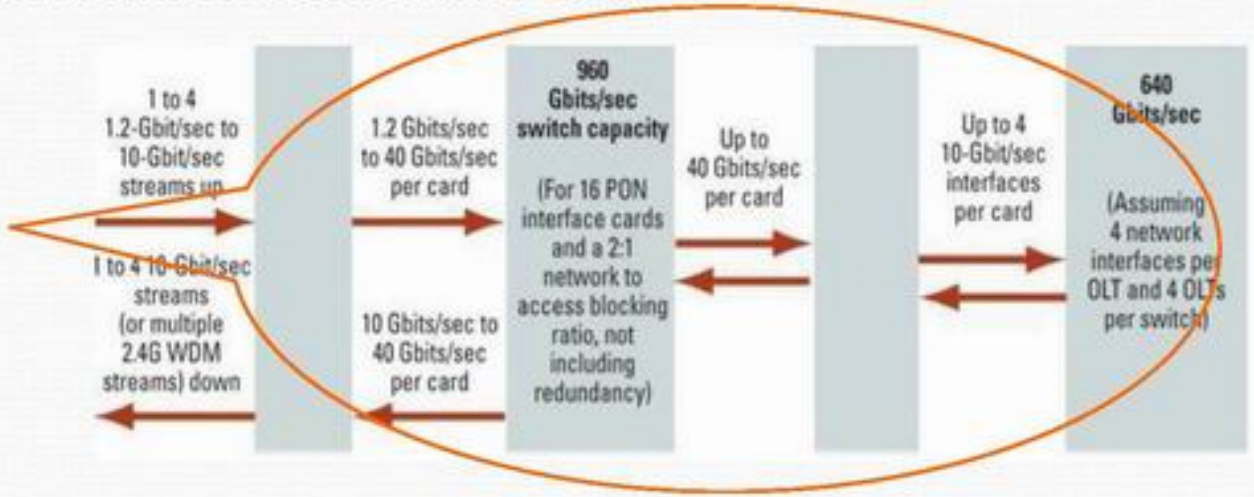
- Asymmetric 10G equipment BOM cost per subscriber is already comparable, if not lower than, to 1G EPON, given the fact that 10G to 1G EPON optical split ratio is 128:16. Large 1G EPON installation base in East Asia makes it possible for 10G volume production in relatively short time frame, further reducing equipment cost.

- Infrastructure CapEx is significantly lower today than it used to be, because of the backplane 10G and 40G devices are already commodity today.

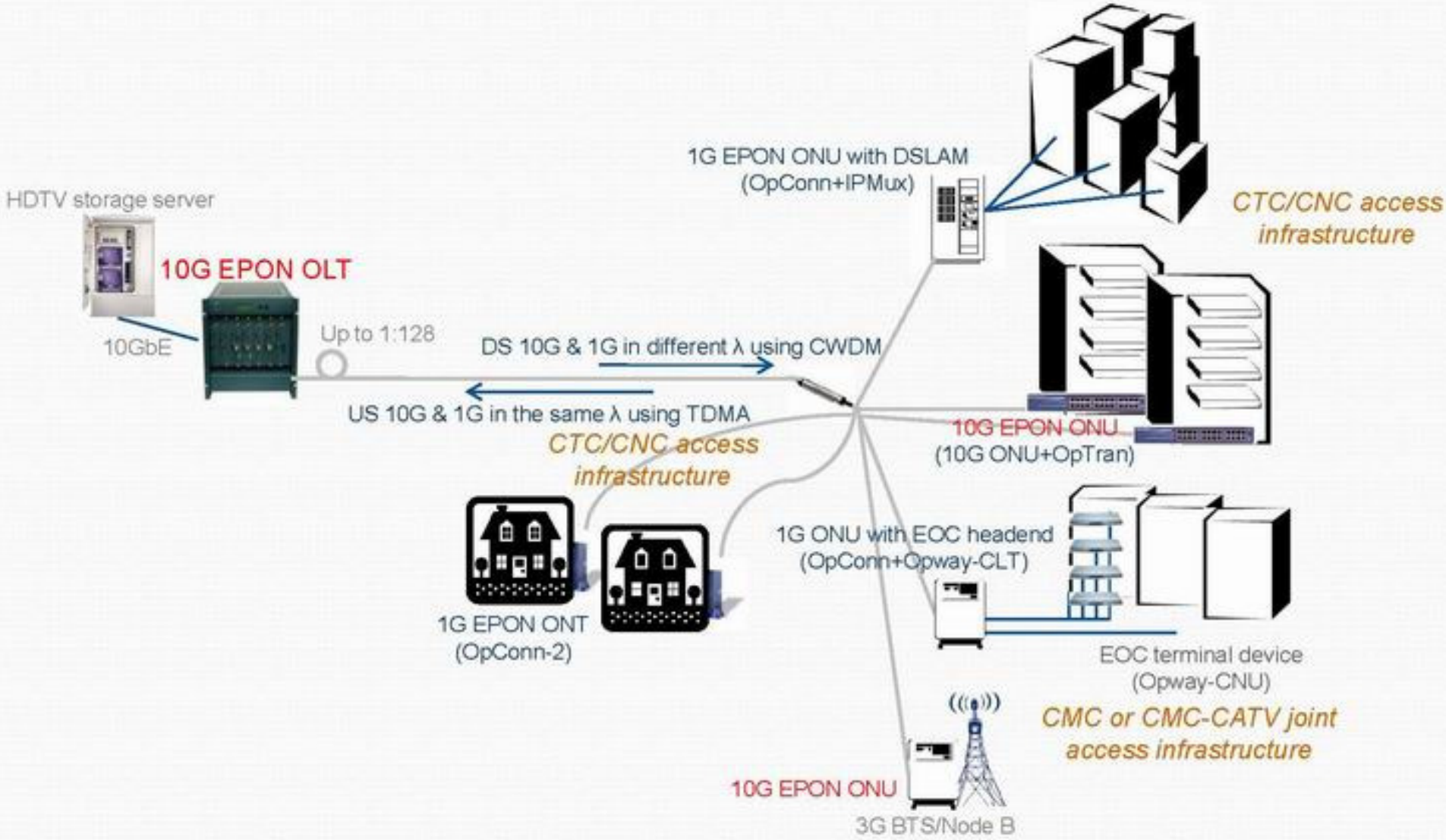
- Factor of downward compatible allows 10G OLT to communicate with 1G ONUs in field; This helps preserve capital investment made in 1G ONU deployment.

- Significantly lower port count in CO and technology maturity and simplicity contribute to an easy service maintenance requirement, thus reduces service providers' OpEx.

10G and 40G switch fabric and NIC are in common backplane deployment today



“All Roads Lead To 10G EPON”



Standardization Briefing

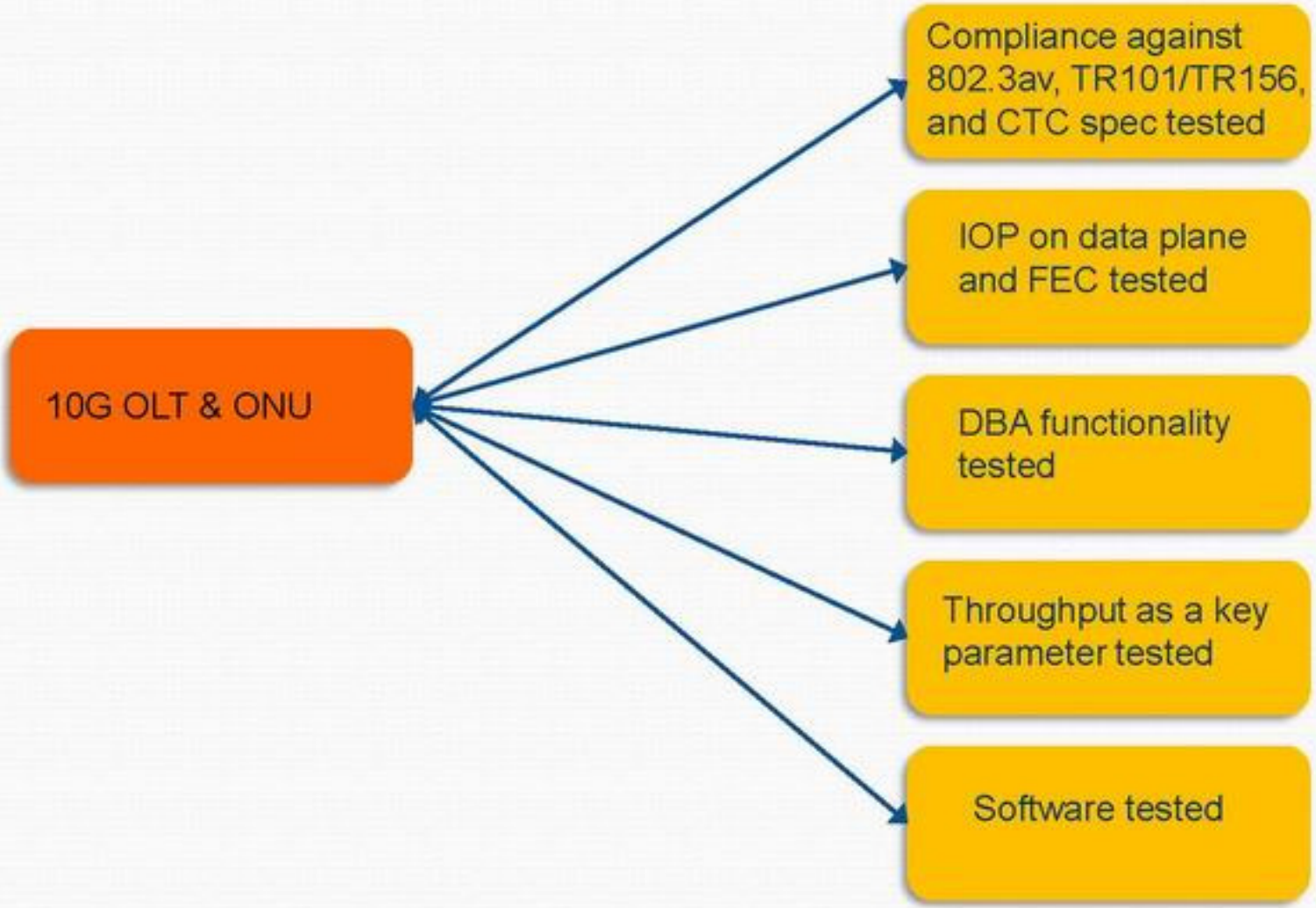
IEEE 802.3av specification embraces the following key characteristics:

- 10G & 1G EPON co-existence is guaranteed:
  - Combination of CWDM (separate 1G and 10G in DS) and TDMA (combine 1G and 10G in US in same λ, use of CWDM to separate 1G and 10G optional)
  - Common VoIP & CES scheme used for voice and other TDM clients by both 1G and 10G
  - Each ONU has one unique LLID, and multiple LLID per ONU supported
    - LLID value of 7F-FF is associated with SCB MAC for 1Gbps DS operation
    - LLID value of 7F-FE is associated with SCB MAC for 10Gbps DS operation
  - 10G OLT accommodates a much higher optical splits, up to 128 ONUs, than 1G OLT, and allows a large numbers of mixed 1G and 10G ONUs, eliminating the need for 1G OLT in CO where 10G OLT is in existence

- Benefited from the standard process of Ethernet/GE/10GE/40GE, 10G EPON assures high usability, and a clear development path or high predictability, i.e., no "technological risk"

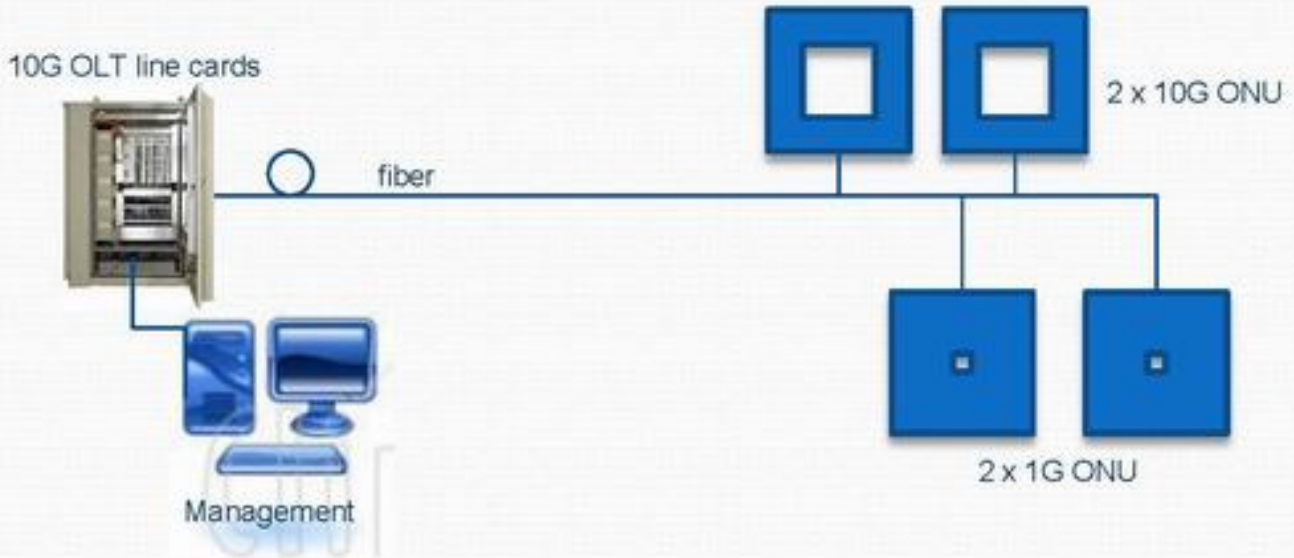
There is no noticeable progress from FSAN for next generation GPON

CTC 10G EPON IOP Test Highlights



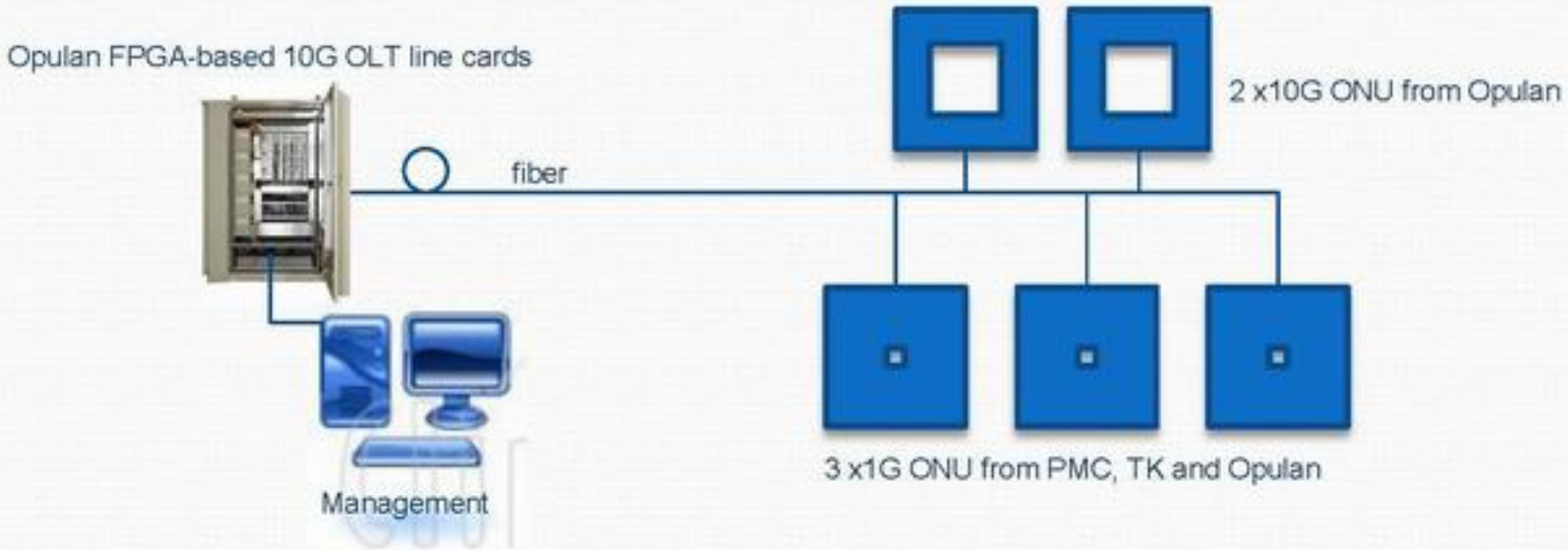
CTC 10G EPON IOP Test Highlights

- Participants in this IOP: PMC, Opulan, Teknovus and HiSilicon
- Opulan's 10G OLT & ONU are the only devices that are able to demonstrate throughput beyond 9Gbps, while others performed between 2 – 8.5Gbps
- Opulan's 10G OLT & ONU are able to interoperate with all others, showing the best interoperability
- Opulan's 10G OLT shows full VLAN manipulation, TR-156 compliance and full bridge capability

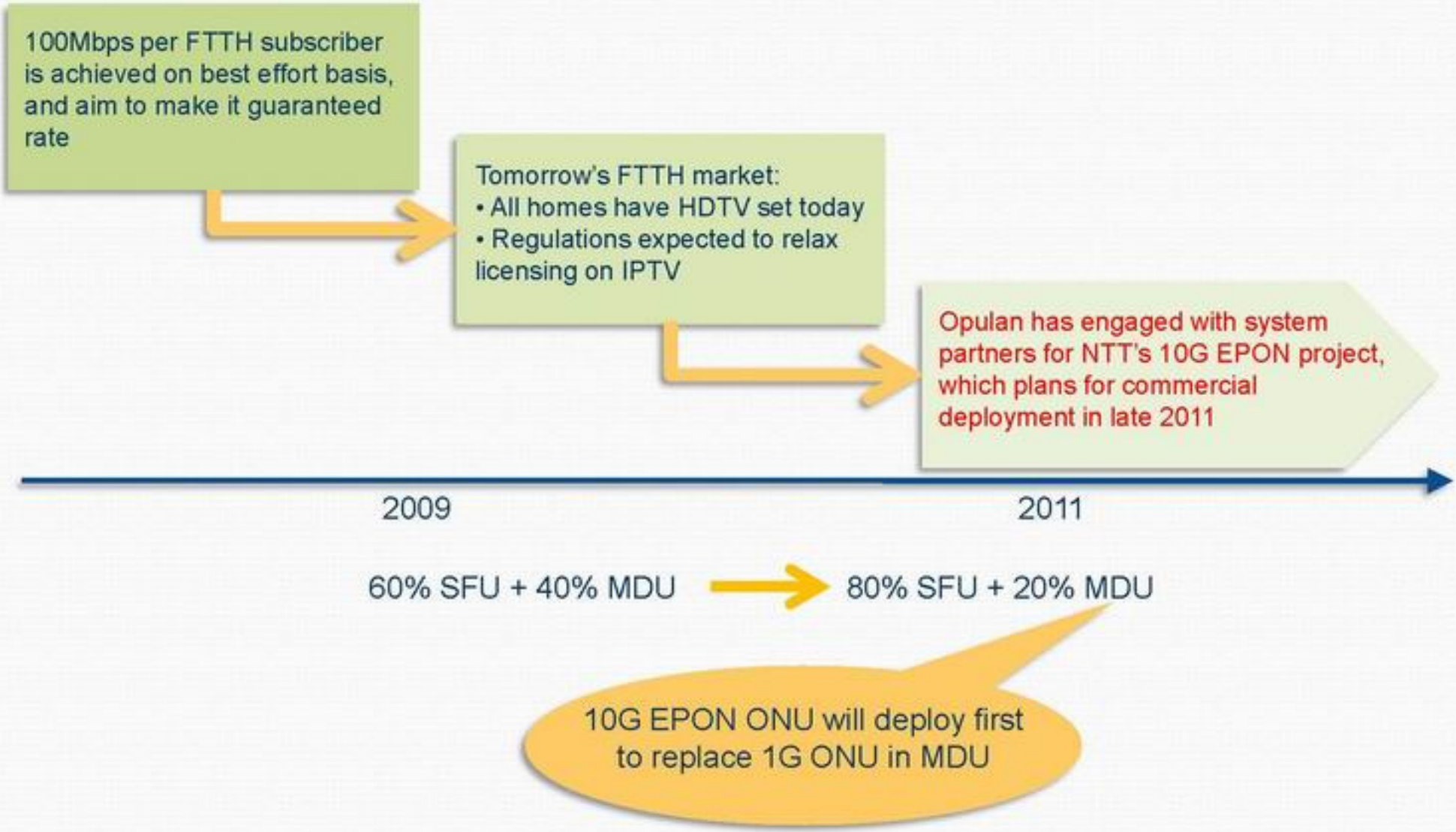


10G EPON Engagement

- Prior to CTC IOP test, 10G EPON systems already running with the configuration of mixed ONUs from Opulan, Teknovus, and PMC of both 1G and 10G, and Opulan 10G OLT for several months
- 10G EPON systems are in field trial managed by ZTE, with Opulan's FPGA inside
- Successful 10G EPON demonstrations performed to NTT's equipment suppliers in Japan
- RFP from Alcatel-Lucent was called for earlier this year; Opulan's proposal was submitted to its Raleigh, North Carolina headquarter, through Opulan's strategic partner, TranSwitch



NTT's 10G EPON Migration



10G EPON Field Trial In China

- **Dong Guan, Guangdong** China Telecom plans a to conduct new field trial in Dong Guan, Guangdong Province for 10G EPON, in September 2009

- **Nanjing, Jiangsu** China Mobile has started field trial in Nanjing, Jiangsu Province for 10G EPON in August 2009

- Their systems are developed and supported by ZTE

- Opulan is fully engaged in 10G EPON FPGA development for the above

Opulan Introduction

- Founded in summer, 2003 by a team of highly experienced technical and management professionals from Silicon Valley, California.

- Headquartered in Shanghai, currently employed about 110 staff, with 100% R&D in Shanghai and Beijing.

- A proven global leader in the xDSL aggregation market, and the sole chip vendor today that offers complete chip solutions for xDSL, EOC and EPON broadband access.

- Opulan's FPGA passed 10G EPON IOP test in July 2009, conducted by CTC, with most complete feature set and highest throughput tested among the participants.

- Awarded by Ministry of Science and Technology and Shanghai Municipal Committee of Science and Technology with over five million Yuan in last four consecutive years.

- Opulan's mission – become a China-based, semiconductor leader in the global communication market.

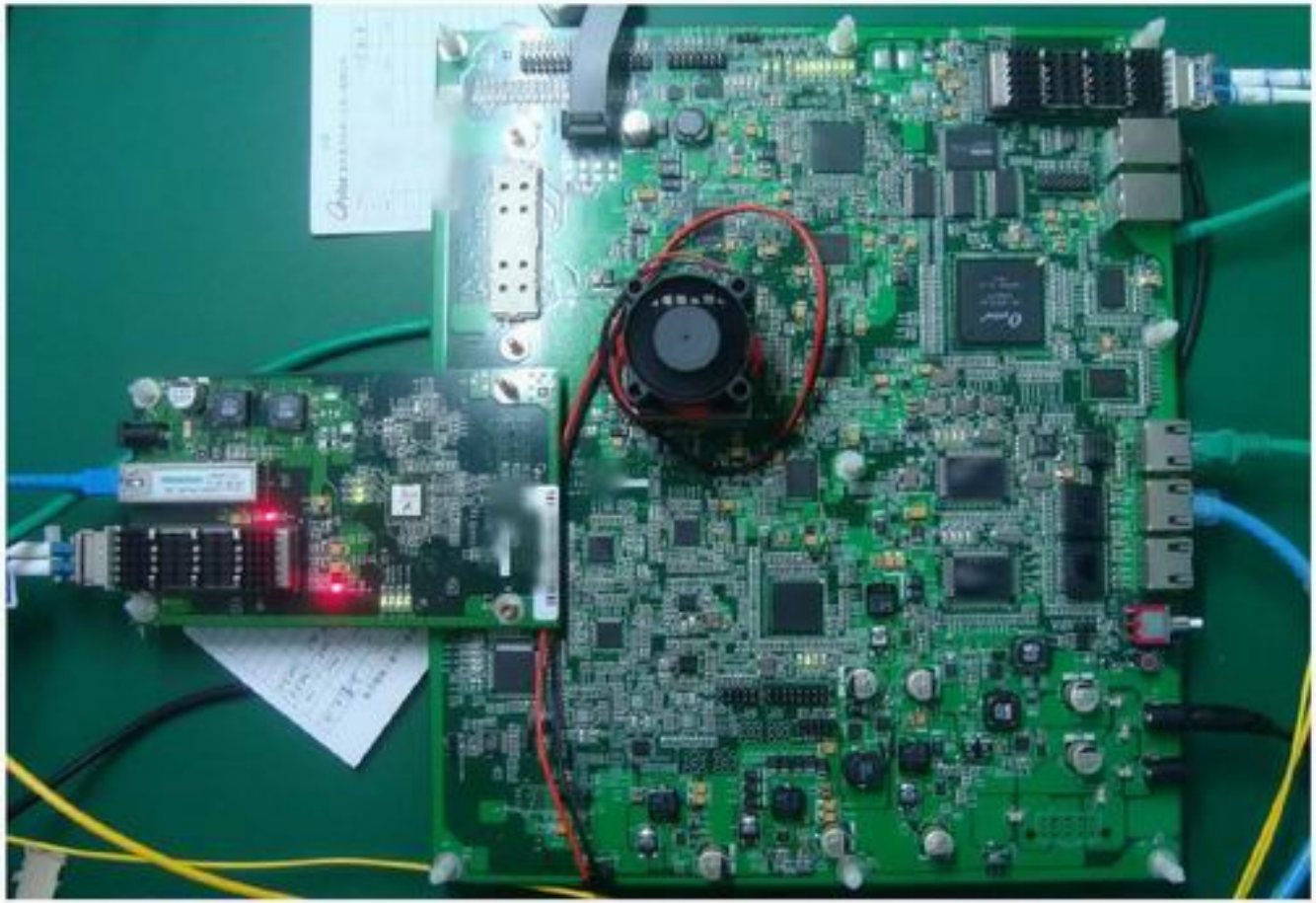
Opulan 10Gbps EPON Highlights

- Standard compliance
  - 802.3av 2.1 Draft, 10G EPON MAC
  - 802.3ah, 802.3 2005, 1G EPON MAC
  - TR-156 service architecture
  - Fully downward compatible with 1G EPON by CTC specification

- Support 10G/10G symmetric mode and 10G/1G asymmetric mode
- Configurable, single or multiple LLID mode
- Up to 16 Unicast LLIDs (1 can be configured by OLT and the rest can be configured through OAM process), 2 configurable broadcast LLIDs
- Full bridge capability
- Fully TR-156 compliant, superior traffic management with VLAN manipulation & LLID scheduling
  - VLAN or VLAN + COS to LLID binding
  - Queue to LLID dynamic Mapping

10G EPON Reference Design

- 10G EPON reference design kit will be available in Q4 2009
- 10G EPON OLT and ONU FPGA fully tested, ready for field trial
- Interoperable with other vendors' 1G and 10G EPON chips
- Technical documents available upon request



Opulan EPON Roadmap

10G OLT

10G ONU

10G OLT

10G ONU

10G domain

1G domain

1G OLT

1G ONU

1G ONU VoIP Enabled

1G ONU Switch Enabled

Q3, 2009

Q2, 2010

Q1, 2011

ASIC

ASIC

FPGA

Interoperable

Opulan Product Strategy

Broadband Access
Complete chip solutions

xDSL access
- LMux, NMux
- IPMux, IPMux-2

EOC access
- Opway-EOC
- Alternative EOC

PON access
- EPON OLT & ONU
- 10G EPON OLT and ONU

Wireless backhaul

Local Presence, Global Vision

Opulan's goal -

- By leveraging well-established EPON infrastructure,
- By strengthening local talent and knowledge on EPON ecosystem and beyond,
- By facilitating a win-win collaboration among service providers, OEMs and chip vendors,
- China will be a true worldwide leader of Information Superhighway!

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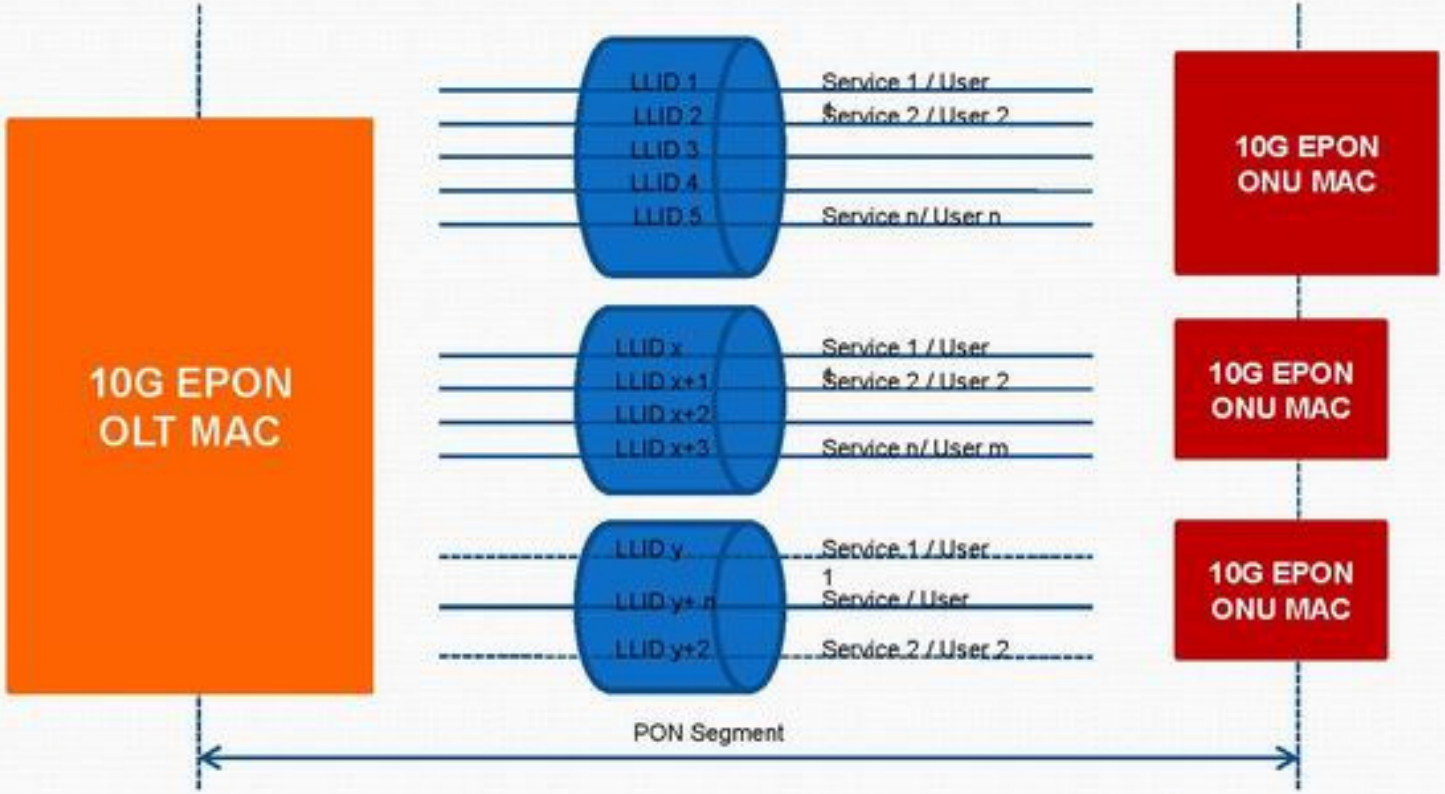
Back-up slides

(in case when questions are raised)

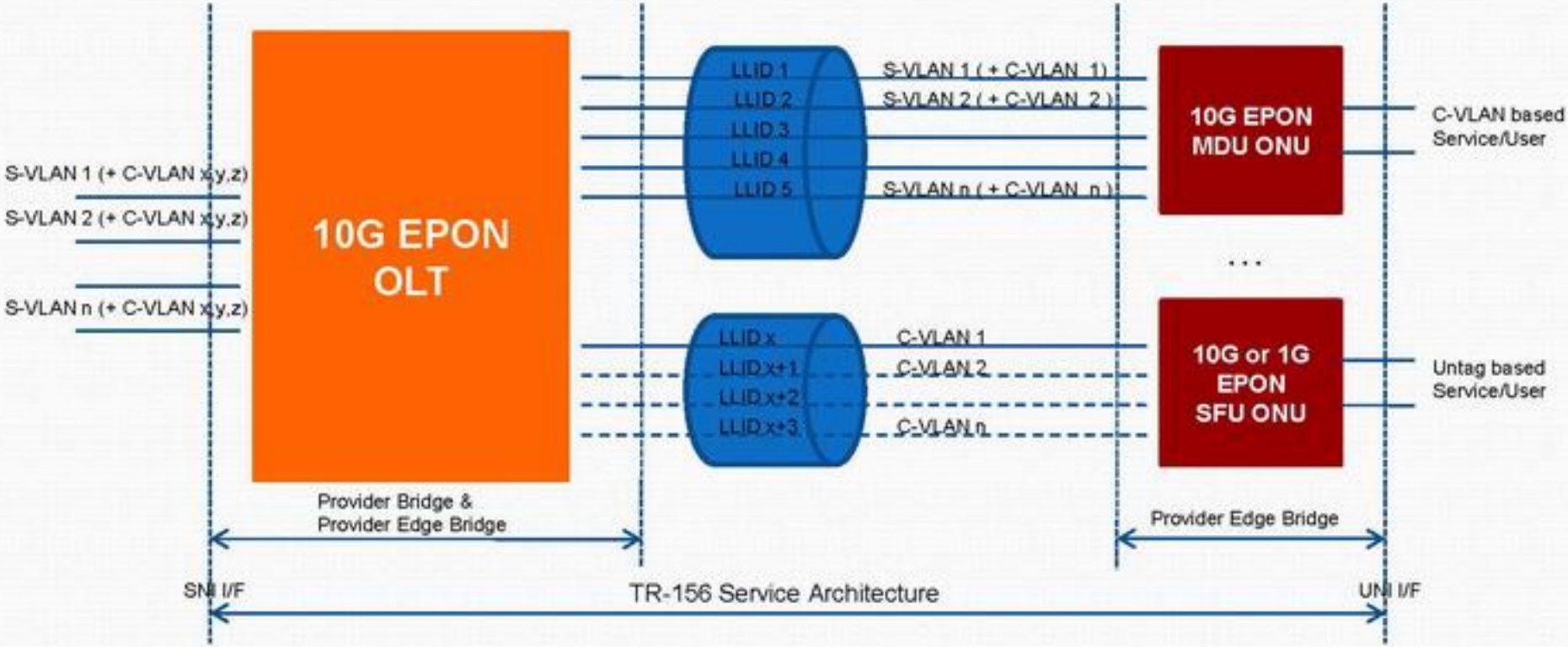
Multiple LLID For Multi-Service



Multiple LLID transport for PON segment

- LLID-Based channel BW allocation and scheduling
- Reliable and controllable transport
- Up to 16 LLID supported in one ONU
- Service/user to LLID binding
- Unique GPON-like multiple LLID solution: base LLID discovery, multiple LLID Grants merge etc

TR156 Architecture For Multi-Service



TR156 Multiple Service Access Architecture Between UNI &SNI:

- Fine scheduling on C-VLAN, S-VLAN, C-VLAN + S-VLAN based service
- C-VLAN, S-VLAN to identify user and service respectively
- Provider edge bridge for ONU to handle untag and Ctag, TR-101 compliant
- Provider bridge & edge bridge for OLT to handle Ctag and Stag